INTERNATIONAL ATOMIC ENERGY AGENCY
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION
INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
I.C.T.P., P.O. BOX 586, 34100 TRIESTE, ITALY, CABLE: **CENTRATOM TRIESTE**

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

INTERNATIONAL CENTRE FOR SCIENCE AND HIGH TECHNOLOGY
c/o INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS 34100 TRIESTE (ITALY) VIA GRIGNANO, 9 (ADRIATICO PALACE) P.O. BOX 586 TELEPHONE 040-224572 TELEFAX 040-224575 TELEX 460449 APH 1

SMR/760-56

"College on Atmospheric Boundary Layer and Air Pollution Modelling"
16 May - 3 June 1994

"Blue Skies"

R. DEININGER
School of Public Health
The University of Michigan
Ann Arbor (MI), USA

Please note: These notes are intended for internal distribution only.

BLUE SKIES

The two articles following this page were written by Professor Perry Samson, which has one of the most exciting and interesting projects underway to bring life sciences into the classroom. He and his students have developed graphical computer programs which allow students to interact with the latest information on weather and environmental data. The data come directly from the U.S. Weather Service and NASA, and international organizations like WMO.

Blue Skies is a science center on the "information super highway".

He is actively seeking users in Europe and the Middle East. He can be reached electronically at:

SAMSON@UMICH.EDU

R.A. Deininger
RAD@UMICH.EDU

BLUE-SKIES: A NEW INTERACTIVE TEACHING TOOL FOR K-12 EDUCATION

Perry J. Samson, Alan Steremberg, Jeffrey Ferguson, Michael Kamprath, Jeffrey Masters, Michael Monan, and Tracy Mullen

University of Michigan
Ann Arbor, Michigan

1. THE WEATHER UNDERGROUND

The University of Michigan **WEATHER UNDERGROUND** provides a link between the scientists and facilities of the University of Michigan and the teachers and students of primary and secondary education in the State of Michigan for the specific goal of making science more accessible. A range of computer services are being developed which will provide interactive access to current weather, climate change, and environmental information. These services include:

- *UM-WEATHER*—A textual, menu-driven system allowing access to the current weather and forecasts for the United States and Canada. The UM-WEATHER service is accessed via the command 'telnet downwind.sprl.umich.edu port=3000'. This service currently accommodates around a quarter million sessions a week.

- *BLUE-SKIES*—A graphical interface allowing interactive access to weather and environmental images and animations.

This project takes advantage of a unique computer network capacity within the State of Michigan, named MichNet, which provides local phone ports in virtually every major city in the state (Figure 1). The project also makes use of the resources available to the university community via the University Corporation for Atmospheric Research *UNIDATA* program. Curriculum development (Samson et al., 1994) is in collaboration with the Michigan Earth Science Teachers Association.

Corresponding author address: Perry J. Samson, University of Michigan, Dept of Atmospheric, Oceanic and Space Sciences, Ann Arbor, MI 48109-2143 [e-mail: blueskies@umich.edu].

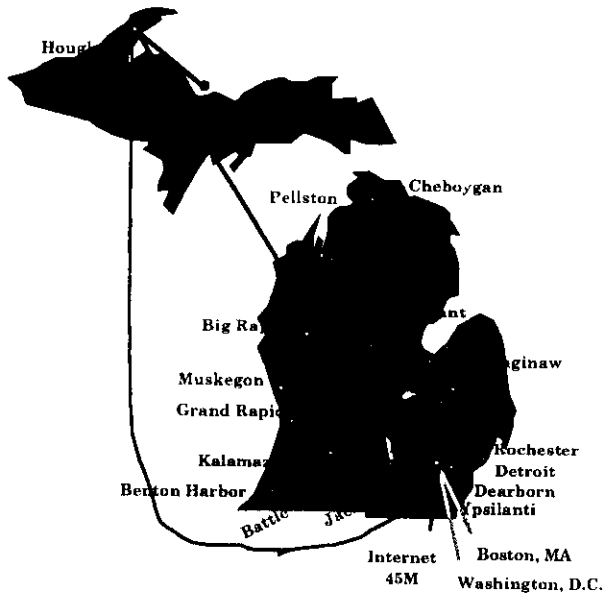


Figure 1. The topology of MichNet, a state-wide computer network allowing local dialup to computers within the State of Michigan.

2. BLUE-SKIES

One technical goal of the Weather Underground is to develop software that will retrieve, display, and manipulate weather data available via either dial-in MichNet ports or the Internet. To this end, a unique weather display system has been created, dubbed "**BLUE-SKIES**." This software is designed to provide an extremely user-friendly interface so that users with a minimal computer background can easily obtain the information they need. Upon start-up an interactive folder is opened as shown in Figure 2 listing the wide range of topics available.

The BLUE-SKIES program offers users relatively fast access to literally hundreds of real-time weather and environmental images. Among its innovative features is the incorporation of a file transfer protocol based on the University of Minnesota's "*gopher*" (though we call it "*groundhog*")

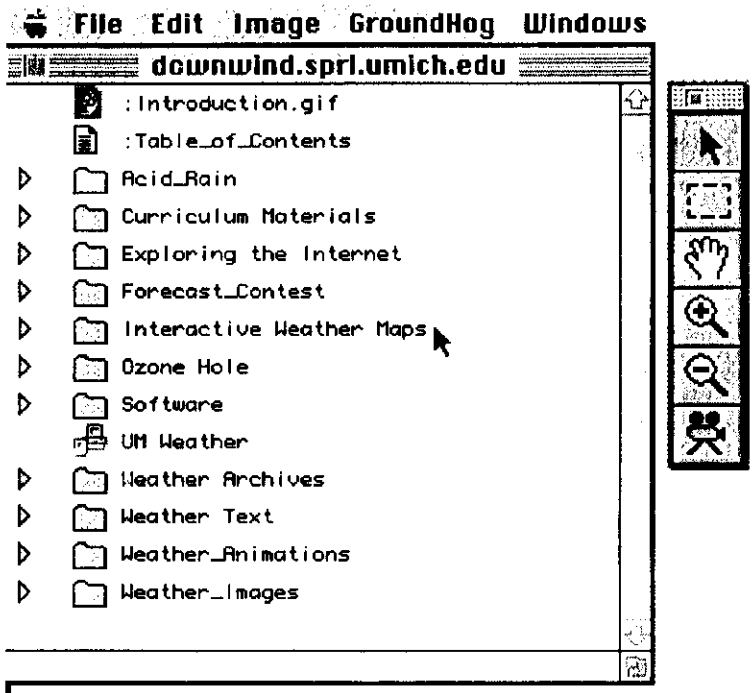


Figure 2. Introductory folder accessed by BLUE-SKIES. Each folder can be opened by point and click using the computer's mouse. BLUE-SKIES contains both the weather, climate and environmental imagery, as well as access to other gopher servers and bulletin board systems relevant to teaching about the atmospheric sciences. The tool palette contains utilities for copying pats of images. moving images with the hand, and zooming and

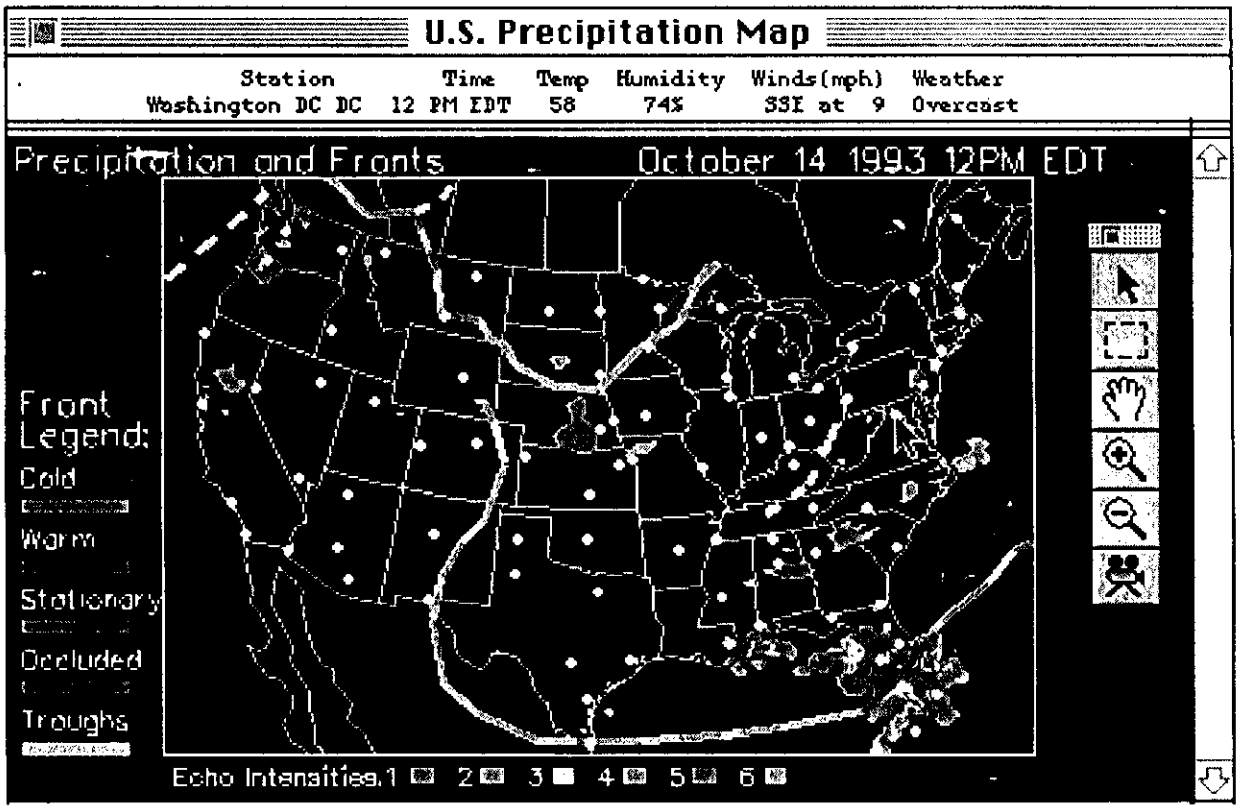


Figure 3. Interactive precipitation map showing location of fronts and precipitation on base map while allowing interactive interrogation of surface data. The movement of the cursor over the city 'dots' causes the current weather reading for that city to be displayed. Clicking on the city with the arrow cursor causes the current forecast for that city to be displayed. As shown, the zoom tool has been selected and clicking as positioned will display a higher resolution map with all available DDPLUS sites to be shown as in Figure 4.

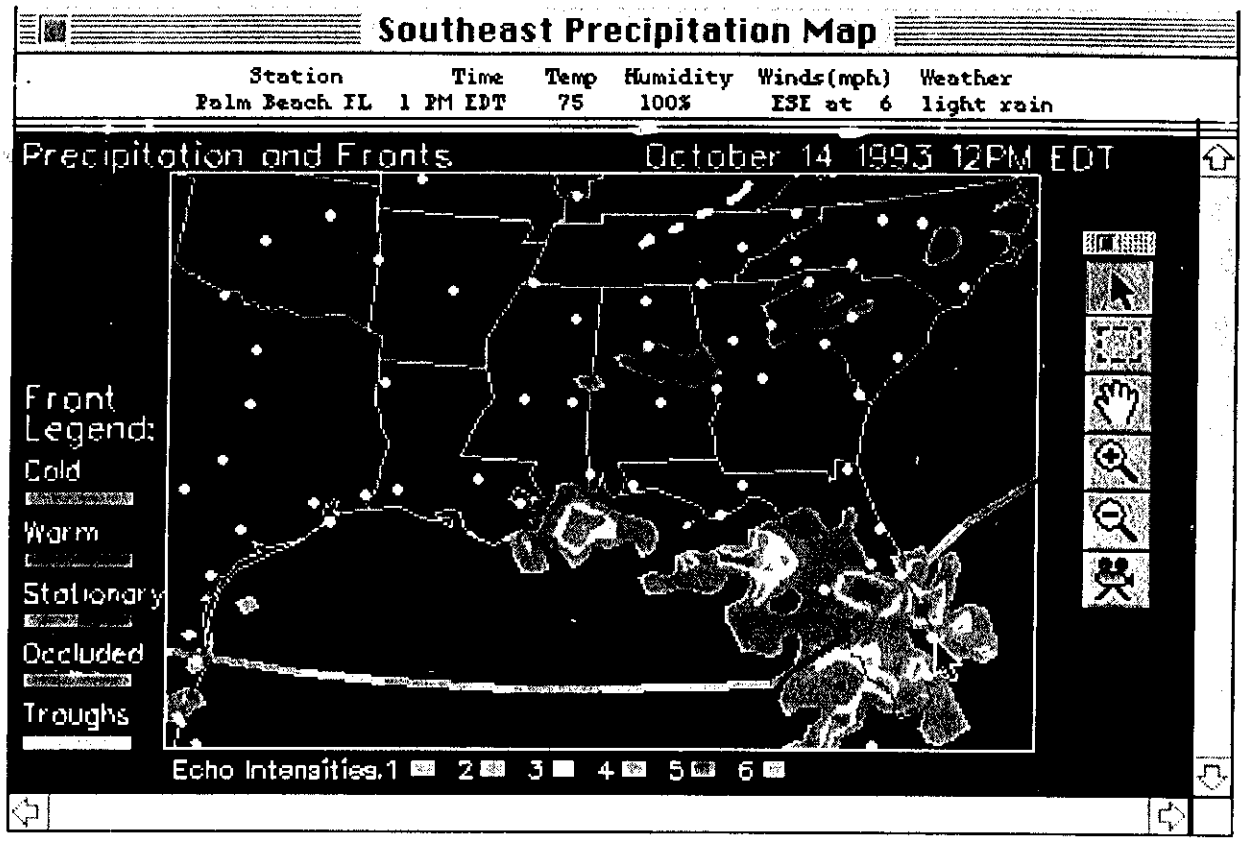


Figure 4. Zoomed interactive precipitation map from Figure 3 for the southeastern United States. The movement of the cursor over the city 'dots' causes the current weather reading for that city to be displayed. Clicking on the city with the arrow cursor causes the current forecast for that city to be displayed.

service. BLUE-SKIES is a full gopher client, with the extra weather and graphics capabilities that current Macintosh gopher clients do not support. The gopher protocol allows for easy control of the graphical user interface, the addition of special topics that can be dynamically updated without altering the client.

2.1 Interactive Weather Maps

A unique feature of the BLUE-SKIES program is the availability of Interactive Weather Maps, which contain a weather image (e.g. radar map with fronts, satellite image, etc.) in which all textual information on current conditions and forecasts is embedded (see Figure 3, for example). There are cities plotted throughout the map, and as the computer mouse passes over the cities, the current conditions (temperature, wind direction and speed, etc.) are shown on a status bar. If the user clicks on the city, the latest National Weather Service forecast for that city is displayed. The user also has the capability to zoom in on selected regions of the country (see Figure 4), allowing more cities to be displayed and allowing greater exploration of weather phenomena.

The interactivity allows students to explore basic questions of meteorology, such as "What are the changes in winds, temperature and relative humidity across a cold front," or "What is the relationship of precipitation to low pressure systems?"

2.2 Weather Images

Static weather images provide a snapshot of the clouds, precipitation, winds and other meteorological variables. The BLUE-SKIES program provides a range of weather images created locally for distribution. The images are transferred via the point and click architecture of the 'groundhog' server to the host machine where the user can:

1. Save the image to disk;
2. Print the image to black and white or color printers; and/or
3. Copy images from BLUE-SKIES into a report for presentation.

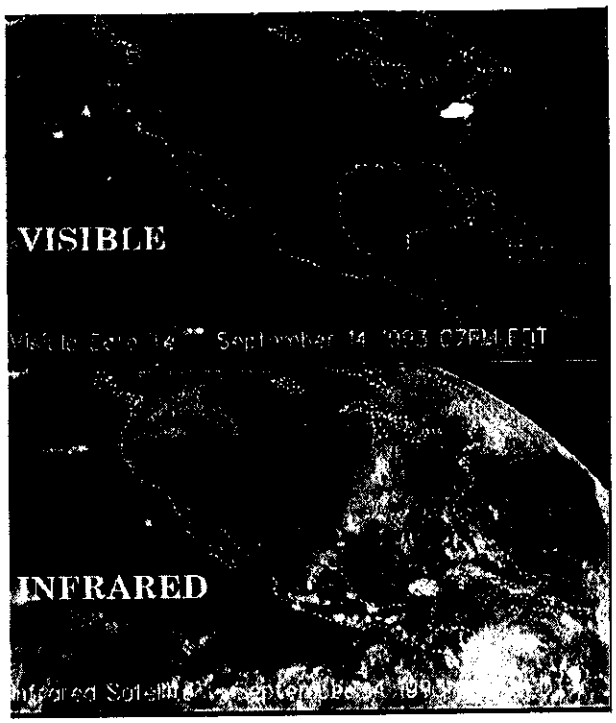


Figure 5. Illustration of visible and infrared imagery available via BLUE-SKIES. Parts or all of these images can be copied into a separate report or presentation, printed to a black and white or color printer, or saved for future use. Images are updated hourly and are generally available to the system about 45 minutes after the picture was taken in space.

2.3 Weather Animations

Weather is, of course, a decidedly non-static phenomenon. The BLUE-SKIES program acknowledges this by allowing access to Quicktime™ movies of the latest several hours of satellite imagery, as well as precipitation and frontal movements, temperature changes, and wind field changes. The animations are created and updated hourly on an IBM RS/6000 workstation using Apple software.

The animations can be set to loop continuously, or can be manipulated on a frame-by-frame basis to study the details of storm movement. The animations can also be saved locally for future use.

2.4 Environmental Images

While the display of weather information is the primary goal of BLUE-SKIES, there is no limitation to the breadth of information which can be disseminated via this technology.

To the end of providing environmental information for teachers and students the BLUE-SKIES program contains folders relating to the Ozone Hole and Acid Precipitation.

2.4.1 Ozone Hole

Recent images of the percent of normal ozone column, as reported by the TOMS satellite is made available as it is released by NASA. These images empower the students and teachers to observe the raw data at the earliest opportunity. The data are released in an unverified form, which force the participants to evaluate whether the results seem plausible, given the risk of erroneous data in the raw data

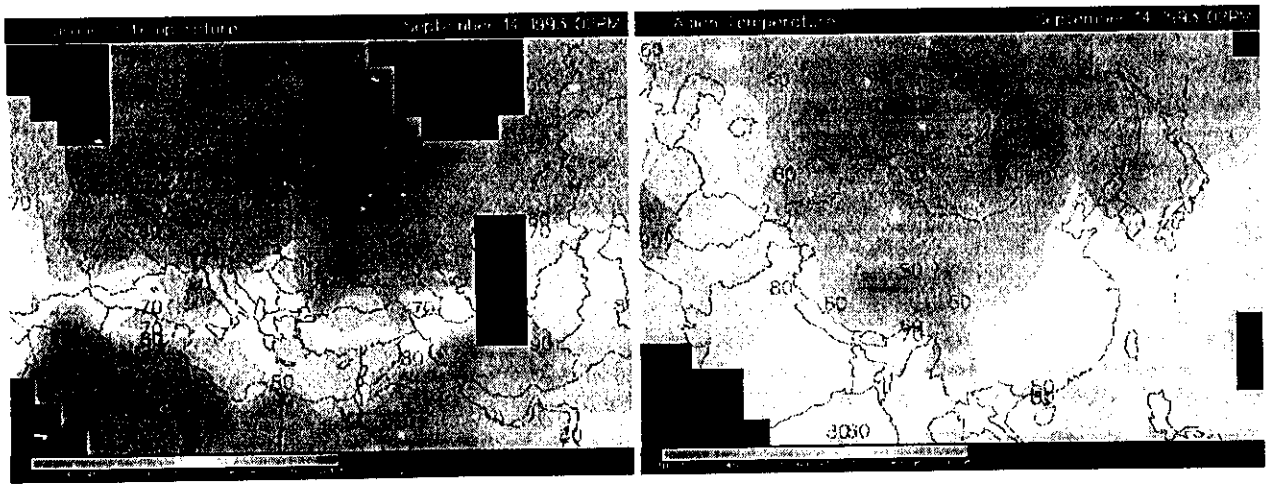
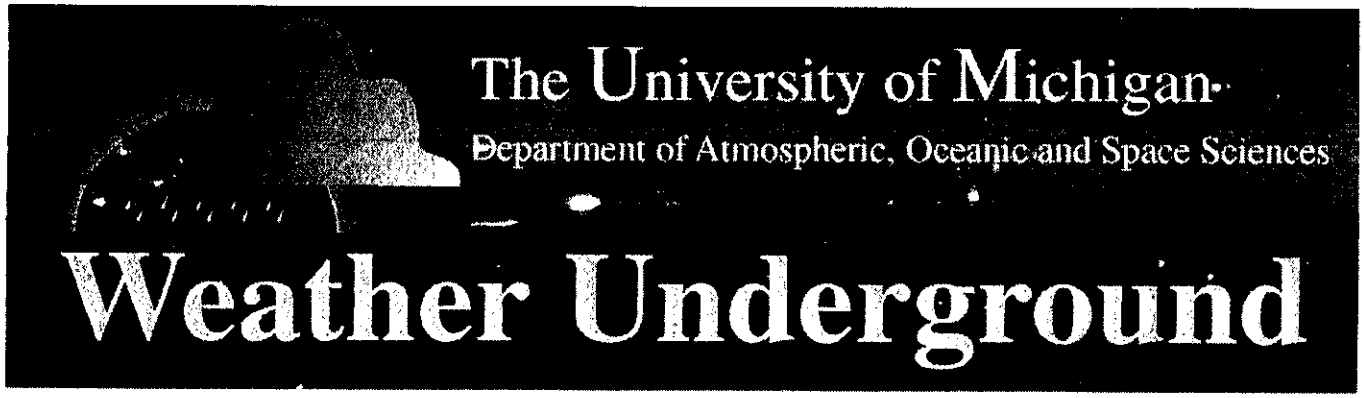


Figure 6. The availability of current weather conditions for other parts of the world allow students to follow weather events worldwide. This also allows ties with non-science classes when weather influences world events.

stream.



WEATHER AS THE PARADIGM FOR INSTRUCTIONAL TECHNOLOGY

The University of Michigan **WEATHER UNDERGROUND** provides a link between the scientists and facilities of the University of Michigan and the teachers and students of primary and secondary education in the State of Michigan for the specific goal of making science more accessible. A range of computer services are being developed which will provide interactive access to current weather, climate change, and environmental information. These services include:

- *UM-WEATHER*—A textual, menu-driven system allowing access to the current weather and forecasts for the United States and Canada; and
- *BLUE-SKIES*—A graphical interface allowing interactive access to weather and environmental images and animations.

This project takes advantage of a unique computer network capacity within the State of Michigan, named MichNet, which provides local phone ports in virtually every major city in the state (Figure 1). The project also makes use of the resources available to the university community via the University Corporation for Atmospheric Research *UNIDATA* program. Curriculum activities have been developed in collaboration with the Michigan Earth Science Teachers Association.

The UM-WEATHER™ program can be accessed over the Internet via the command 'telnet madlab.sprl.umich.edu 3000'.

The BLUE-SKIES™ program can be retrieved either from the gopher server at 'groundhog.sprl.umich.edu' in the folder 'software' or via anonymous ftp from 'madlab.sprl.umich.edu' in directory /pub/Blue-Skies.

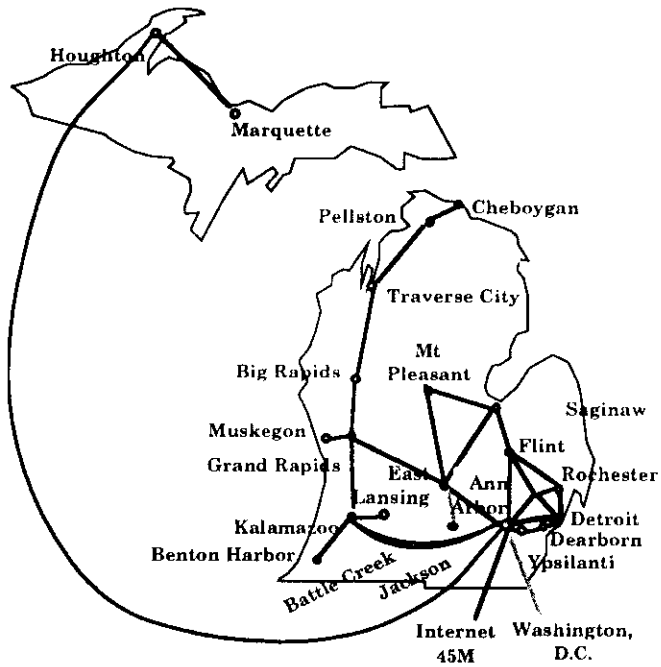


Figure 1. The topology of MichNet, a state-wide computer network allowing local dialup to computers within the State of Michigan.

BLUE-SKIES™

One technical goal of the Weather Underground is to develop software that will allow users to input, retrieve, and display weather data available via either dial-in MichNet ports or the Internet. To this end, a unique weather display system has been created, dubbed "**BLUE-SKIES™**." This software is designed to provide an extremely user-friendly interface so that users with a minimal computer background can easily obtain or input information.

The BLUE-SKIES™ program offers users relatively fast access to literally hundreds of real-time weather and environmental images using a new gopher protocol for interactive graphics. While BLUE-SKIES is a full gopher client, it includes protocols for interactive graphics that current Macintosh gopher clients do not support. This gopher protocol (dubbed 'groundhog') allows for easy control of the graphical user interface, the addition of special topics that can be dynamically updated without altering the client.

Interactive Weather Maps

One unique feature of the BLUE-SKIES program is the availability of Interactive Weather Maps, which contain a weather image (e.g. radar map with fronts, satellite image, etc.) in which all textual information on current conditions and forecasts is embedded (see Figure 2, for example). There are cities plotted throughout the map, and as the computer mouse passes over the cities, the current conditions (temperature, wind direction and speed, etc.) are shown on a status bar. If the user clicks on the city, the latest National Weather Service forecast for that city is displayed. The user also has the capability to zoom in on selected regions of the country, allowing more cities to be displayed and allowing greater exploration of weather phenomena.

Interactivity allows students to explore basic questions of meteorology, such as "What are the changes in winds, temperature and relative humidity across a cold front," or "What is the relationship of precipitation to low pressure systems?"

Interactivity

Through a unique interface students can also input their own observations into BLUE SKIES™. Observations of minimum and maximum temperatures, precipitation amount and type and a textual description of interesting weather-related situations can be input. Subsequently the schools will appear as 'dots' on a zoomed weather map and the school name, observation and student's name will pop to the top as the cursor is moved across the screen.

This ability to interact and to contribute to the weather data base directly makes BLUE-SKIES™ a powerful tool to empower students to be an active part of the international environmental data stream.

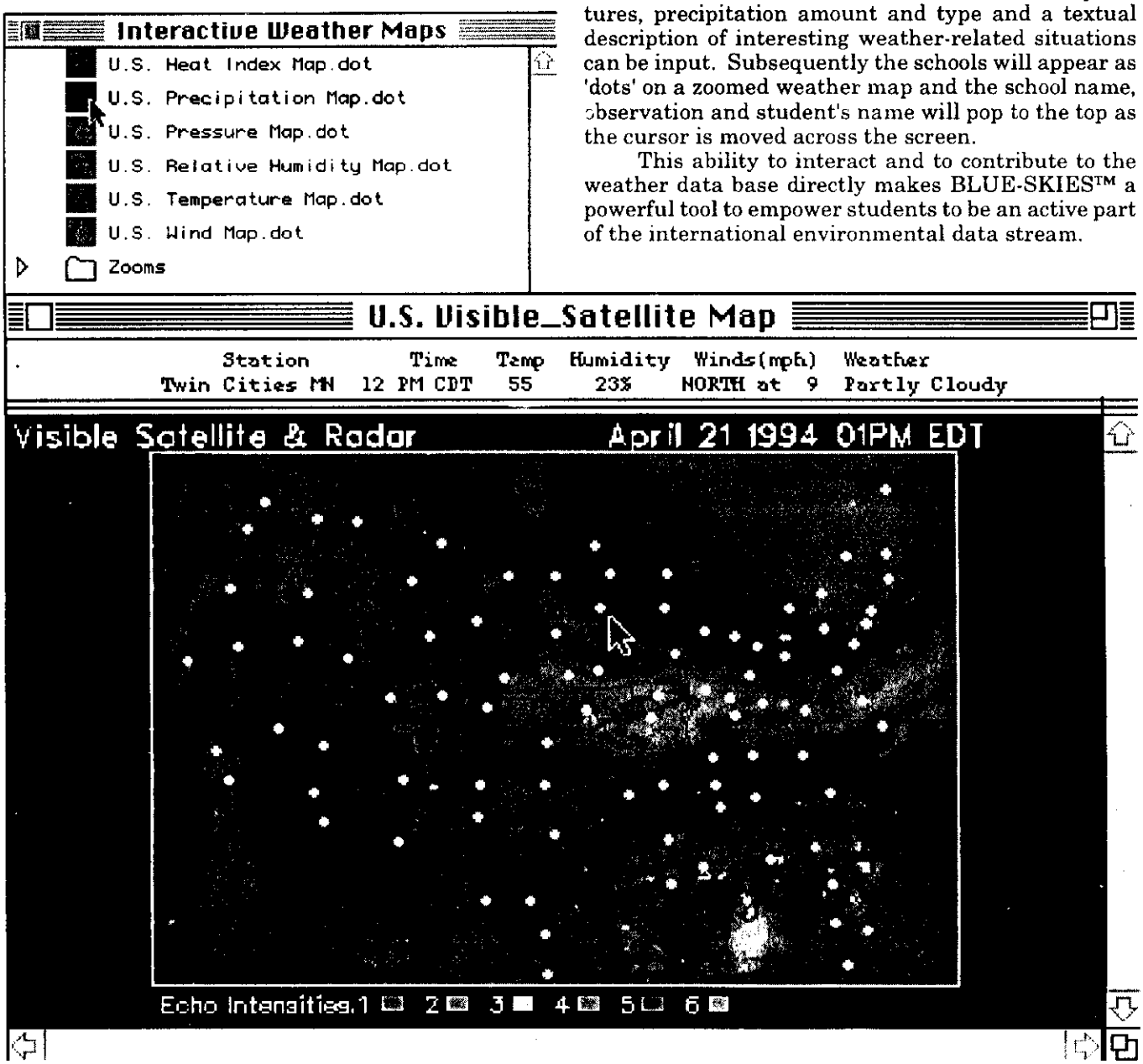


Figure 2. Illustration of interface to an **Interactive Weather Map** and a map showing the current conditions for the Twin Cities, MN. As the mouse is moved around the screen the name of the underlying city and its current weather report are displayed above the map.

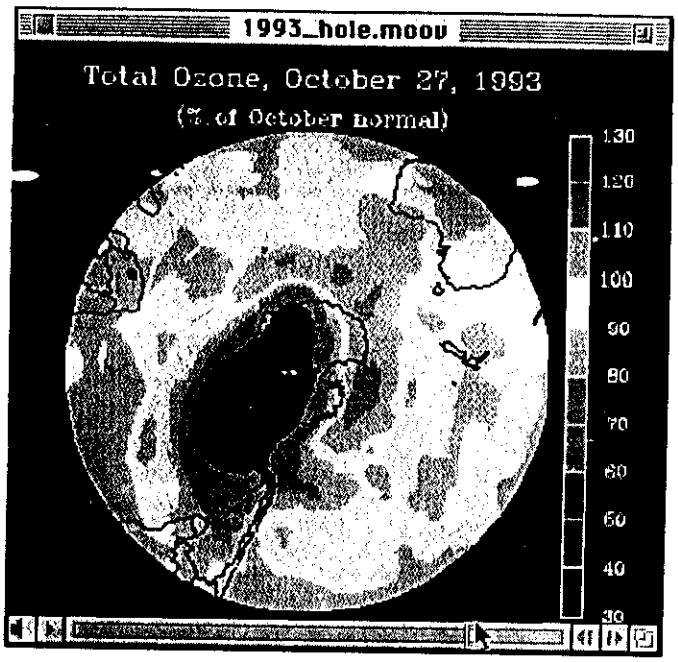


Figure 3. Movie made of daily summaries of total ozone column during the Fall of 1993 and available via BLUE-SKIES™. Images received from NASA allowed students to observe day-by-day development of ozone hole.

Real-Time Animation

Weather is, of course, a decidedly non-static phenomenon. The BLUE-SKIES program acknowledges this by allowing access to animations of the latest several hours of satellite imagery, as well as precipitation and frontal movements, temperature changes, and wind field changes. The animations are created as Quicktime™ movies and updated hourly.

Beyond Weather

While the input and display of weather and environmental information is the primary goal of BLUE-SKIES, there is no limitation to the breadth of information which can be disseminated via this technology. For example, the BLUE-SKIES program contains folders with both archives and quasi-real-time ozone hole information (see Figure 3) and archives of daily precipitation chemistry data.

Curriculum Development

Hand-in-hand with the development of the BLUE-SKIES program has been the creation of curriculum activities for the K-12 classrooms. These activities have been developed in collaboration with the Michigan Earth Science Teachers Association and national organizations such as the American Meteorological Society's Project Atmosphere. Inasmuch as nature seldom cooperates with course planning a special folder containing archives of selected weather phenomena has been created. This folder contains images and data corresponding to hurricanes, tornado outbreaks, snow storms, and other materials useful for classroom projects.

This folder also contains a new interactive map featuring all weather gophers nationwide. Te hers and students need only point at the dot for the server and click to get access to the many other weather gophers providing imagery across the nation.

Bookmaps, a map of worldwide hosts containing images germane to specific curriculum activities, will be prepared so the user can pull up relevant images without needing to know *a priori* where in the world they reside.

ACCESSIBILITY

The Weather Underground Program includes six areas of concern to education:

- Resource Development;
- Content Coordination;
- Education Coordination;
- Regional Network Infrastructure;
- Local School Infrastructure; and
- Training Coordination.

We are particularly concerned with accessibility in both content and infrastructure so that the program, by its design, is not exclusive to the better students or the more financially secure schools. Within Michigan this has resulted in the widespread reliance on dial-in access to the Internet using the Merit Networks "Point-to-Point Protocol" (PPP). This allows schools to invest, at first, in relatively inexpensive high-speed modems which can interact with MichNet to form a pseudo-Internet connection. The BLUE-SKIES™ software has been designed to make the best use of this protocol so the imagery can be delivered within a few tens of seconds via modem.

Other avenues the Weather Underground is using to allow as broad access as possible include creation of "Weather Walls" for public interactive display. These are banks of computers built for interactive museum displays or as transportable units to roll into schools which do not have computer facilities. The first Weather Wall has been implemented in the University of Michigan Exhibit Museum.

Also we will soon implement an interactive cable television classroom allowing inexpensive remote class participation. Participants will be able to address questions to the lectern of the lecturer via BLUE-SKIES or UM-WEATHER in real-time.

For more information: Please contact Prof. Perry J. Samson, Weather Underground, University of Michigan, Department of Atmospheric, Oceanic and Space Sciences, Ann Arbor, MI 48109-2143 [e-mail: blueskies@umich.edu]